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| REPORT D[OCUMENTATION PAGE] | Form Approved OMB No. 0704-0188 |
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|---|---|---|
| 1. AGENCY USE ONLY (Leave blank) | 2. REPORT DATE April 1993 | 3. REPORT TYPE AND DATES COVERED FINAL |

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|---|---|
| 4. TITLE AND SUBTITLE The Need for An Anti Satellite Capability in the Twenty-First Century | 5. FUNDING NUMBERS |
| 6. AUTHOR(S) Robert S. Ward Lt Col, USAF | |
| 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) AIR WAR COLLEGE 325 CHENNAULT CIRCLE MAXWELL AFB AL 36112-6427 | 8. PERFORMING ORGANIZATION REPORT NUMBER Unnumbered AWC research paper |
| 9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A | 10. SPONSORING/MONITORING AGENCY REPORT NUMBER N/A |

11. SUPPLEMENTARY NOTES

PAPER IS WRITTEN TO FULFILL ACADEMIC RESEARCH REQUIREMNTS FOR AN IN-RESIDENCE SENIOR SERVICE PROFESSIONAL MILITARY SCHOOL.

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|---|---|
| 12a. DISTRIBUTION/AVAILABILITY STATEMENT APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED | 12b. DISTRIBUTION CODE |

13. ABSTRACT (Maximum 200 words)

See page iii



| | |
|---|---|
| 14. SUBJECT TERMS Need, Antisatellite, Twenty-First, Century | 15. NUMBER OF PAGES 38 |
| | 16. PRICE CODE |

| | | | |
|---|---|---|---|
| 17. SECURITY CLASSIFICATION OF REPORT UNCLAS | 18. SECURITY CLASSIFICATION OF THIS PAGE UNCLAS | 19. SECURITY CLASSIFICATION OF ABSTRACT UNCLAS | 20. LIMITATION OF ABSTRACT UL |

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# THE NEED FOR AN ANTISATELLITE CAPABILITY IN THE TWENTY-FIRST CENTURY

by

Robert S. Ward
Lieutenant Colonel, USAF

A RESEARCH REPORT SUBMITTED TO THE FACULTY

IN

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Advisor: Colonel Kenneth V. Walsh

MAXWELL AIR FORCE BASE, ALABAMA

April 1993

## DISCLAIMER

# ABSTRACT

TITLE: The Need for an Antisatellite Capability in the Twenty-First Century

AUTHOR: Robert S. Ward, Lieutenant Colonel, USAF

The US must develop an antisatellite (ASAT) capability because it will probably face adversaries in the next century that have access to force-enhancing satellites. This is likely because: (1) satellites made significant contributions to the success of US-led coalition forces in the Gulf War; (2) analysts from other countries have recognized this; (3) many countries already have satellites that could provide their forces with space-based capabilities comparable to those enjoyed by US forces; and (4) more countries will be able to acquire such capabilities.

## BIOGRAPHICAL SKETCH

Lieutenant Colonel Robert S. Ward (BS, Columbia University; MS, University of Arkansas) is being assigned to US Special Operations Command as a communications staff officer after graduation from Air War College. He has had a variety of unit-level assignments entailing fixed, tactical, and airborne command post communications systems. He also served as an instructor at Air Command and Staff College. His military assignments have enabled him to travel extensively throughout Europe, Central America, and the Middle East. Colonel Ward is a graduate of Squadron Officer School and Air Command and Staff College.

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# CHAPTER I

## INTRODUCTION

Desert Storm has been described by US Air Force Chief of Staff General Merril A. McPeak and others as "the first space war."[1] While US military forces have used space-based assets to varying degrees for more than 20 years, satellites played a prominent role in the Gulf War. As General Donald J. Kutyna, former Commander in Chief, US Space Command, explained to the Senate Armed Services Committee shortly after the war ended, "Desert Storm was the first campaign-level combat operation where space was solidly integrated into combat operations and was vital to the degree of success achieved in the conflict."[2] One of the major reasons the US was able to integrate space was because it had built a robust system of satellites over the past 20 years that were available to its forces when the conflict began. Conversely Iraq did not have any satellites, even though Saddam Hussein had, reportedly, tried to buy some reconnaissance satellites that China was developing, from Brazil.[3] Even if Iraq had had its own satellites, or access to those of other nations, the US-led coalition undoubtedly would have still prevailed. However it may have taken longer and resulted in a greater number of casualties. Coalition forces probably would not have been able to execute the ground campaign's massive "left hook" as easily if

Iraqi forces knew it was coming. But unable to conduct aerial surveillance after its air forces were grounded by coalition air supremacy, Iraq had no alternative method to determine coalition force dispositions. General H. Norman Schwartzkopf, then Commander in Chief, US Central Command (CENTCOM), was well aware of this. As he explained to newsmen, "when we knew [Iraq] couldn't see us anymore, we did a massive movement of troops all the way out to the west."[4] The rest is history.

The US, in all probability, will become involved in military conflicts again. We may not be so lucky to face an adversary as ill-equipped as Saddam Hussein was in 1991. In the twenty-first century it is more likely we will find ourselves opposed by military forces that have access to satellites similar to those available to US forces in the Gulf War. To overcome those forces as quickly as possible and minimize US casualties, the US requires an antisatellite (ASAT) capability to deny an adversary use of those satellites. It is beyond the scope of this paper to recommend a specific type of ASAT. However, it will develop the position that the US must develop such a capability. First, it will demonstrate how US forces effectively used satellites during the Gulf War to enhance combat operations. Then it will briefly illustrate the interest that effective use of satellites has generated. Next, this paper will examine satellites other nations already have or are developing. Finally, it will explain how more nations may be able to acquire satellites in the future.

## CHAPTER II

## USE OF SATELLITES IN THE GULF WAR

US military forces effectively used a variety of satellites to facilitate combat operations during the Gulf War. This chapter identifies some of the satellites they used and illustrates how US forces used them.

### Communications Satellites

US military forces relied extensively on communications satellites during the Gulf War. Fifteen US and NATO military satellites, augmented by several civil satellites, provided virtually all intertheater circuits for voice, message, facsimile, and video communications, as well as more than 85 percent of the intratheater communications.[1] Super high frequency (SHF) communications satellites provided most of this capability. In August 1991 the US only had two SHF communications satellites in geosynchronous orbit over the region--one Defense Satellite Communications System (DSCS) II and one DSCS III satellite. Together, they were capable of providing slightly more than 600 voice circuits for theater use.[2] Anticipating this would not be sufficient for future operations, Air Force Space Command reconfigured the DSCS II satellite to increase its circuit capacity. It also repositioned a reserve DSCS II satellite from the Pacific theater. The US also obtained authorization to use NATO's Skynet 4B SHF satellite. These actions provided coalition forces over 500 additional voice circuits.[3]

Six US Navy Fleet Satellite (FLTSAT) Communications and three Leased Satellite ultra high frequency (UHF) satellites augmented the SHF satellites, providing US forces with an additional 98 voice circuits.[4] Furthermore, an experimental extremely high frequency (EHF) transponder on one of the FLTSAT satellites was activated to provide a secure, jam-resistant channel between General Schwartzkopf and General Colin J. Powell, Chairman of the Joint Chiefs of Staff.[5] Finally, two experimental single-channel UHF Multiple Access Communications Satellites (MACSATs) were made available to the first US Marine units that deployed.[6]

Because of the vast distances involved, US forces had to rely on satellites for communications with bases in the US and supporting commands throughout the world. Similarly, the lack of an adequate communications infrastructure within the region forced US forces to depend on satellites for intratheater communications as well. These factors led General Powell to state, "satellites were the single most important factor that enabled us to build the command and control network for Desert Storm."[7] SHF satellites linked CENTCOM headquarters in Saudi Arabia with US European Command headquarters in Germany and US Transportation Command headquarters in the US, enabling them to coordinate deployment and logistics support. UHF satellites linked the first 82d Airborne Division elements in Saudi Arabia to its headquarters at Ft Bragg, enabling them to coordinate follow-on deployments.[8] The MACSATs allowed the 2d Marine Aircraft Wing in theater to obtain essential logistics support from its home station in Cherry Point.[9]

US also forces relied on satellites for communications within theater. They became a primary means for disseminating directions, intelligence, and warning from CENTCOM headquarters to units throughout the theater. They were even used to pass information between units, such as when a DSCS circuit was reportedly used to pass a pilot report, through the Theater Air Control Center, to ground units engaged in combat.[10]

Because of the constraints imposed by distance, terrain, and an inadequate regional communications infrastructure, the US had to rely on communications satellites for effective communications in the Gulf War. As General Kutyna testified to the Senate Armed Services Committee, "Effective command and control of US and coalition forces simply would have been impossible without . . . satellite communications systems."[11]

## Navigation Satellites

US forces relied extensively on navigation satellites to pinpoint their own locations and target enemy positions. They depended on the precision provided by the US NAVSTAR Global Positioning System (GPS). This system operates on the principle of being able to determine the exact distance between known points and using radio signals to calculate position by a process of triangulation.[12] In August 1991 the GPS consisted of a constellation of 16 satellites, one of which was not operating properly. Within a few days, Air Force Space Command satellite controllers restored the malfunctioning one to limited service. Consequently, all 16 satellites transmitted their signals continuously for the entire Gulf War.[13] Because of the system's orbital parameters, personnel with GPS receivers were able to receive three-dimensional position information to within 25 meters for about 16 hours a day. But they also could receive two-dimensional information to within eight meters, 24 hours a day.[14]

US forces used this information in countless ways. In the opening moments of Desert Storm, Special Operations MH-53J Pave Low helicopters, specially equipped with GPS receivers, guided eight Army AH-64A Apache helicopters at night to two Iraqi early warning radars, where the Apaches destroyed the radars, opening the path for the initial air strike on Baghdad.[15] GPS receivers aboard Air Force tankers allowed them to fly precise refueling tracks.[16] B-52 navigators used GPS receivers to locate targets.[17] F-16s used the GPS to fly to initial points on night bombing runs before switching to their Low-Altitude Navigation and Targeting Infrared for Night systems.[18] Similarly, Navy pilots used the GPS to fly to release points and launch stand-off land attack missiles (SLAMs). Once they launched a SLAM, it would update its inertial navigation system from the GPS signals. Then, as Lt Gen Thomas S. Moorman, Jr., Commander of Air Force Space Command explained, "One SLAM would open a hole in the target and the next SLAM would go through the hole and blow up the target."[19]

Strike aircraft, working with ground forces, achieved similar results. Ground forces used GPS receivers to determine their exact location on the ground. After determining distance to an enemy target with a laser range finder, they would pass precise target coordinates to incoming strike aircraft.[20] In addition to pinpointing targets, ground forces used GPS receivers to maneuver around the featureless desert. XVIII Airborne Corps and VII Corps units "relied on GPS receivers to keep track of their locations during the encirclement of the Republican Guard."[21]

The 101st Air Assault Division commander called GPS receivers "the most popular new piece of equipment in the desert."[22] The GPS proved so effective that receiver manufacturers were unable to keep up with the demand for them. It was not uncommon for soldiers to take up collections and write manufacturers directly, if they were unable to get one through normal supply channels.[23]

## Weather Satellites

US forces also relied on satellites to provide them with meteorological information throughout the theater. In August 1991 the US only had two Department of Defense weather satellites in orbit, providing theater coverage every six hours. To ensure that failure of one of these Defense Meteorological Support Program (DMSP) satellites would not reduce coverage, Air Force Space Command launched a replacement DMSP satellite ahead of schedule. As a result before Desert Storm began, three DMSP satellites provided theater coverage every four hours.[24] These satellites carry a variety of sensors that provide detailed environmental data. The primary sensor is a visible/infrared imaging system that provides surface imagery. Other sensors measure temperature and atmospheric moisture, soil moisture, and sea conditions.[25] In addition to the DMSP satellites, some US forces used information provided by US civil weather satellites. Some units reportedly even used weather data from Russian Meteor civil weather satellites.[26]

With information about cloud formations and movement, wind direction, and air moisture content, US forces were able to plan and execute operations effectively, even during bad weather. They could determine when the skies were clear over targets, which was crucial for two reasons. First, the rules of engagement required minimizing civilian casualties and collateral damage, so pilots had to be able to clearly see their targets. Secondly, clear skies over target areas made it possible to use laser-guided weapons, which are less effective in rain, smoke, or haze.[27] DMSP satellite information also enabled planners to avoid haze, dust storms, turbulence, and smoke from the oil fires in Kuwait, when planning target routes and refueling points. DMSP soil moisture content measurements also enabled Army planners to select appropriate routes through southwest Iraq for Army forces to attack the Republican Guard.[28]

## Warning and Imagery Satellites

Satellites also provided valuable warning and imagery to US forces in the Gulf War. Defense Support Program (DSP) satellites helped minimize casualties and preserve coalition solidarity. These satellites were designed to detect intercontinental and sea-launched ballistic missile launches. When Iraqi forces began launching Scud intermediate range missiles at Saudi Arabia and

Israel, the DSP satellites detected them. As soon as US Space Command was able to confirm a Scud launch, it warned CENTCOM and provided essential intercept information to US Patriot missile crews. The entire process took less than five minutes.[29]

Civilian satellites provided valuable imagery information to US forces in the Gulf. The US Landsat system, administered by the National Oceanic and Atmospheric Administration (NOAA), provided some of the imagery. This system, consisting of the Landsat 4 and 5 satellites, provides multispectral imagery (MSI) of the earth. Because of their orbital parameters and sensor characteristics, these satellites provide images in 100 nautical mile segments, with a resolution of about 30 meters.[30] US forces used imagery from these satellites for ocean monitoring, mapping, and terrain analysis. For example, after Iraqi forces began pumping Kuwait's oil into the Persian Gulf, US forces used Landsat imagery to monitor movement of the oil slick for its potential impact on naval operations.[31] Landsat images were also used to provide high quality maps and charts to ground forces. For example, when the XVIII Airborne Corps first arrived in Saudi Arabia, it had very few detailed current maps of the region. Using Landsat imagery, the Defense Mapping Agency made up-to-date regional maps and shipped more than 120 of them to the theater.[32] With these maps, forces were able to identify new buildings, new roads, and roads that had been covered by blowing sand.[33]

US forces also used imagery from the French civil remote sensing satellite system known as SPOT. This system, similar to the Landsat system, also consists of two orbiting satellites.

While they have fewer spectral sensors than Landsat satellites, they have a much better resolution--about 10 meters.[34] The US Navy used SPOT imagery during the war to update ocean charts in the Persian Gulf, especially for relative depths in shallow areas near the shoreline.[35] Other SPOT imagery was used to identify potential amphibious landing beaches.[36] The Air Force made extensive use of SPOT imagery for route planning with its Mission Support System. It obtained over 200 SPOT images of Kuwait and Iraq, including downtown Baghdad. Planners electronically overlaid many of these on digital terrain maps used in mission planning, which gave airmen "a never-before seen capability."[37] They used this system to plan for numerous critical missions, including the successful surgical strike on Kuwait's Mina al Ahmadi oil complex, which stopped the flow of oil spewing into the Gulf.[38]

In addition to imagery from civilian sources, US forces undoubtedly had access to imagery from US national satellites. In fact, D. Brian Gordon, Defense Intelligence Agency Officer for National Systems says, "[civil imagery] represented only a small percentage of the total imagery support."[39] However, since information about US national satellites is classified, the Department of Defense has only publicly alluded to their role in the Gulf War.[40] But given the importance of US interests in the conflict, it is not illogical to think they played a significant role in supporting US forces.

## CHAPTER III

## INCREASED INTEREST IN SATELLITES FOR MILITARY USE

History has shown that when a nation effectively proves a concept on the battlefield, other nations often try to incorporate some of the successful ideas into their military doctrine. Tanks and aircraft became staples of many military forces after World War I. Likewise since World War II, other countries acquired nuclear weapons, and more are trying. The effective use of satellites in the Gulf War validated many previous beliefs about their value as force enhancement tools. Thus in the aftermath of the war, satellites are likely to become similarly desirable, since as Martin Faga, former Assistant Secretary of the Air Force for Space has said, "our military space systems and their crews have shown the whole world that space is fundamental to modern warfare and national security."[1] There have already been some indications that others may share this view.

USAF Captain Brian Collins, an analyst in the Commonwealth of Independent States Military Studies Group at Supreme Headquarters Allied Powers Europe, has examined numerous Gulf War analyses written by former Soviet General Staff officers. According to Captain Collins, while some of these senior officers minimized the decisive role of airpower in the Gulf War, the General Staff admitted that "the coalition's use of space assets in the war was `of definite interest to [them]'"[2]. In addition, they "were impressed with the coalition's ability to transmit space-provided information quickly."[3] European interest in greater military roles for satellites has been more open. For example, retired Royal Navy Rear Admiral Sir Peter Anson and retired Royal Air Force Group Captain Dennis Cummings published their own analysis of the role satellites played in the war, which has been widely circulated in Europe. It concludes with a call for an expanded space capability for European military forces.[4] In the same vein, French officials have stated that "the same reasons that led [them] to build an autonomous deterrent force should lead [them] to build [their] own capability for space observations."[5]

It is apparent that other countries have recognized the utility of satellites in warfighting and may wish to acquire similar capabilities for their own forces. It will not be impossible for them to do so. Non-US satellites already exist that could provide military forces of other countries with the same capabilities US forces had available to them during the Gulf War. And more are becoming available every day.

# CHAPTER IV

## SATELLITE PROGRAMS OF OTHER COUNTRIES

Many countries already have satellites that can perform many of the same functions US satellites perform. Other countries are trying to acquire their own. This chapter examines some of these existing and emerging non-US programs.

### Communications Satellites

Numerous countries have, or are planning to obtain, their own satellite communications systems. Like the US, the former Soviet Union and the United Kingdom currently have communications satellites dedicated to military use. While many technical details are not known, it is apparent the former Soviet Union has a robust military satellite communications infrastructure. Three different constellations of low-earth orbit communications satellites are available to its land, sea, and air forces.[1] Another constellation of eight Molniya I satellites, in higher orbits, is believed to be dedicated for government and military communications. These are supplemented with three additional Cosmos-series satellites in even higher orbits.[2] This extensive system provides them with a capability comparable to existing US military communications satellites.

The United Kingdom also has dedicated military satellites. Its Skynet 4 system, composed of three satellites with SHF and UHF channel capacity, has been operational since 1988. Each satellite is in a geosynchronous orbit designed so British land, sea, and air forces in the Middle East and Far East can communicate with military headquarters in the United Kingdom by secure voice, message, and facsimile.[3] In addition to its own satellite system, the United Kingdom operates the NATO-4 system. This system, while similar to the Skynet 4, is made up of only two satellites and has been operational since 1991. It provides secure diplomatic and military communications between NATO members.[4]

Numerous countries operate their own civil communications satellite systems. These include Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Iran, Japan, Mexico, and Pakistan, among others.[5] It is illogical to assume their military forces would be denied access to these means of communication. Some countries have even added, or are planning to add, systems to their civil communications satellites specifically intended to enhance support to their military forces. For example, France has added a transponder, known as Syracuse, to each of its civil Telecom satellites. This system, which has been operational since 1984, enables the Ministry of Defense and military headquarters to communicate securely with their forces in Europe, the Atlantic, and the Mediterranean.[6] Spain has also upgraded its civil Ibersat/Hipsat communications satellite system to enhance its military utility. A dedicated transponder became operational last year which provides a secure communications capability for military and government use.[7] Similarly, Italy is developing a system known as Sicral. Based on it civil Italsat system, Italy hopes to deploy two satellites with SHF and UHF capability for its military forces in Europe and the Mediterranean.[8]

## Navigation Satellites

Military forces from other countries may be able to use navigation satellites, other than GPS, for precise position determination. The former Soviet Union started testing its own Global Navigation Satellite System (GLONASS) in 1982 and began deploying it shortly after. Somewhat similar to the US GPS, the former Soviet Union planned to bring it on line in two stages. The first, consisting of 10-12 satellites, was intended to provide and initial operating capability. The second stage, consisting of a 21-satellite constellation, was programmed to become operational by 1995. It is designed to provide two-dimensional position accuracy to within 100 meters and three-dimensional accuracy to within 150 meters. So far, 11 satellites have been deployed and receivers similar to US GPS receivers are being developed.[9]

While no other countries have announced plans to develop navigation satellite systems, Motorola Corporation has unveiled a concept to deploy a worldwide cellular telephone communications satellite system called Iridium. Consisting of 77 satellites in multiple orbital planes, it could conceivably be adapted to provide navigational information, using the same principles upon which the GPS is based.[10]

## Weather Satellites

Many nations also have satellites that could provide their military forces with meteorological data, enabling them to fight more effectively. Articles in former Soviet military and scientific journals have routinely recognized the importance of weather data to support military operations.[11] They have been operating an array of weather satellites since at least 1969.[12] A constellation of two to four Meteor satellites provides coverage of more than two-thirds of the globe and they are used to provide meteorological data for military and government, as well as civilian uses.[13] Comparable to the US NOAA weather satellites, they are routinely used to monitor cloud cover, weather fronts, jet streams, storms, and atmospheric moisture content, as well as ice cover of the arctic regions.[14] Another constellation of meteorological satellites, known as Okean, have radar sensors which provide all-weather, day/night capability, and focus specifically on oceanic and arctic climatic conditions.[15] Recently the former Soviet Union also began deploying a new series of satellites, known as Geostationary Operational Meteorological Satellites, to supplement the Meteor and Okean systems.[16]

Japan also has its own weather satellite system. Its Geostationary Meteorological Satellite system began operating in 1978 and provides coverage from Hawaii to India. Similar to the US Geostationary Operational Environmental Satellite system, it transmits weather data from space- and surface-based sensors every 30 minutes.[17] Japan is also planning to supplement this system with a more capable meteorological satellite system, known as the Advanced Earth Observation Satellite, which is designed to provide accurate wind speed measurements over ocean surfaces.[18] India is another nation with its own weather satellite system. Instead of distinct satellites, India has mounted meteorological sensors on its Insat communications satellites. Operating since 1983, this system provides data comparable to the US NOAA system.[19] Since 1988 China has also had its own weather satellites. The Fen Yung constellation also provides data comparable to the US NOAA system. Furthermore, China plans to supplement this system with a new series of geostationary satellites this decade.[20]

## Remote Sensing Satellites

Imagery from remote sensing satellites is already available to military forces of many nations and more will be available in the future. Imagery from the French SPOT system is currently available to anyone willing to pay for it. As already illustrated, US forces used it during the Gulf War. This system will continue to be a viable source of 10-meter resolution multispectral imagery (MSI), as France intends to launch additional satellites in the future.[21] The European Space Agency became another source of imagery since launching its Earth Resources Satellite (ERS-1) in 1991. This satellite, with a synthetic aperture radar sensor, is capable of providing all-weather, day/night radar imagery with a resolution of about 30 meters. The European Space Agency plans to expand its coverage capability by launching a second satellite, ERS-2, this year.[22] Since 1969, the former Soviet Union has also produced commercial imagery. It has used various models of its Resurs series of satellites to produce both MSI and photographic imagery for civil use. MSI from these satellites typically has a resolution of 30 meters.[23] However, photographic imagery is even better. Resurs satellites with high resolution cameras eject film canisters that return to earth. Their imagery products have a resolution of about five meters.[24] Russia expanded its remote sensing capability in 1991 by launching a new series of Almaz satellites. These satellites, which have both synthetic aperture radar and MSI sensors, produce imagery with a resolution of 15 meters or better.[25] As with SPOT imagery, Resurs and Almaz imagery is available to anyone willing to pay for it.[26]

Japan also has a remote sensing satellite capability. Since 1987, it has operated the Marine Observation Satellite system. In addition to carrying sensors that monitor meteorological and oceanic conditions, it also carries MSI sensors to analyze coastal vegetation and terrain. This system produces imagery with a resolution of 50 meters.[27] Japan greatly enhanced its capability by launching a more advanced satellite, known as the Japan Earth Resources Satellite, in 1992. Like the Russian Almaz, it carries both synthetic aperture and MSI sensors, producing 18-meter resolution imagery.[28] India also has its own remote sensing satellites. The first Indian Remote Sensing satellite was launched in 1988, followed by a second in 1991. Its MSI sensors currently provide imagery with a resolution of less than 37 meters.[29]

Other countries are planning to acquire their own remote sensing satellites. China and Brazil have been working on a system and hope to launch the first of two satellites this year. Its MSI sensors are expected to provide 20-meter resolution imagery.[30] Canada is also developing a remote sensing satellite called Radarsat. Carrying a synthetic aperture radar, it is expected to provide 10-meter resolution radar imagery after it is launched in 1994.[31]

## Warning and Intelligence Gathering Satellites

Some countries already have satellites capable of providing warning and intelligence information to their military forces. Other countries may have similar capabilities in the future. The former Soviet Union has satellites believed to be capable of providing warning of missile launches. They have had a constellation of nine satellites operating since 1987 that, reportedly, is capable of detecting intercontinental ballistic missile launches and pinpointing launch locations.[32] In addition, some observers believe they have supplemented this system with a geosynchronous system capable of detecting submarine-launched missiles.[33]

The former Soviet Union also has electronics intelligence (ELINT) gathering satellites. One system consists of six satellites, the first of which was launched in 1970.[34] They began deploying another six-satellite system in the 1980s, which may have been designed to supplement or replace the first system. These ELINT satellites are reportedly able to locate radar and radio emissions, which might enable military forces to identify command and control centers, forward battle elements, and air defense radars.[35] Based on past comments attributed to Soviet military officers, these ELINT satellites may even be capable of intercepting communications.[36] The former Soviet Union has separate ELINT satellites specifically focused on naval forces. The first of these ELINT Ocean Reconnaissance Satellites (EORSATs) was launched in 1974. The former Soviet Union has reportedly maintained a six-satellite constellation of these in orbit since 1990.[37] Reportedly, they are capable of identifying types of ships and their roles, from their radar and radio transmission characteristics, and pinpointing their location to within two kilometers.[38]

In addition to warning and ELINT satellites, the former Soviet Union has a vast array of surveillance and reconnaissance satellites. To complement their EORSATs, the former Soviet Union has operated a system of Radar Ocean Reconnaissance Satellites (RORSATs) since the 1960s, intended "to detect, identify, and track US and Allied naval forces."[39] They began deploying a new generation of RORSATs in 1985, with a reported "resolution of tens of meters."[40] As with most of their other reconnaissance satellites, RORSATs can be maneuvered to new orbits to focus on specific areas of interest.[41] The former Soviet Union has also had a photo reconnaissance capability since at least 1962. It has had at least five generations of satellites since then. The first two generations have been phased out with more capable versions. The first third-generation satellite was launched in 1968 and upgraded versions may still be used today. The early models were placed in orbit for 10 to 30 days and then returned to earth with their cameras and film.[42] In 1979, the former Soviet Union apparently began using Resurs-F satellites in place of the earlier version. Instead of the entire spacecraft returning to earth, it merely ejects film canisters for recovery.[43] In 1975 the former Soviet Union began deploying a fourth generation of satellites. These usually remain in orbit for up to two months and are believed to do the bulk of the very high resolution photo reconnaissance work. Like the Resurs-F satellites, these also return their imagery to earth in recoverable film canisters. They also frequently maneuver to new orbits.[44] The former Soviet Union began deploying a fifth generation of satellites in 1982. Unlike earlier ones, these generally stay in orbit for six to eight months and do not maneuver as frequently as earlier generations. For this reason, Western observers believe their primary mission may be wide area surveillance, rather than reconnaissance. Furthermore, they do not appear to eject film canisters, suggesting they return their imagery electronically.[45]

China is another country who currently deploys satellites known to be used solely for intelligence gathering. China has routinely launched satellites, known as the FYW series, since 1975. Like many of the former Soviet Union's reconnaissance satellites, they return imagery to earth in recoverable film canisters.[46] In addition to the former Soviet Union and China, a growing number of other countries appear to be interested in using satellites to obtain intelligence imagery. In 1985 the French Ministry of Defense announced its intention to develop a military satellite reconnaissance capability, based on SPOT remote sensing technology.[47] Since then, France has joined with Italy and Spain to develop the Helios reconnaissance satellite. Planned for launch in 1994, the French claim it will have a resolution of about one meter. Some Western observers believe it could also have an ELINT capability.[48] In addition to France, the United Kingdom has been studying a space-based radar surveillance concept, although it has not announced plans to develop one.[49] Also, since Israel began testing its own satellites in 1988, there is some speculation they may be trying to develop their own reconnaissance satellite.[50] And recently, Spain, South Korea, and the United Arab Emirates approached US companies about building reconnaissance satellites for them.[51]

# CHAPTER V

## INCREASING CAPABILITY AND AVAILABILITY

From the preceding examination of non-US satellites, it is apparent the US does not have a monopoly on them. Almost every capability that satellites provided US forces in the Gulf War could also be available to military forces opposed to the US in future conflicts. This danger could become even greater in the Twenty-First Century if satellites become more capable and more countries are able to obtain them.

### Improved Reconnaissance Capability

Civil remote sensing platforms already have some military utility as crude intelligence gathering platforms. Those with resolutions of only 20 meters may still be capable of detecting runways, ship formations, large troop concentrations, ports, and some roads.[1] However, because of the orbits they are typically placed in, most existing civil remote sensing satellites provide imagery which may not be timely or detailed enough for military purposes.[2] But these limitations could be overcome if a nation decided it wanted timely, more detailed imagery. To produce more timely imagery, a nation need only put such a satellite in an orbit that would focus only to regions that nation was interested in. It may not desire imagery of the entire globe. Similarly, a nation need only put such a satellite in a lower earth orbit to improve its imagery resolution. Improving the resolution of such satellites would enable them to identify or detect smaller objects, giving them much more military utility. More powerful sensors would also give such satellites a greater reconnaissance capability.

It is not unreasonable to speculate that technological advances in the next 10 to 20 years could make more powerful sensors a reality. After all, the French apparently have been able to develop 1-meter resolution Helios sensors less than ten years after developing their 10-meter SPOT sensor.[3] Proliferation may enable less technologically-equipped nations to acquire sensors powerful enough for reconnaissance applications. Technology sharing has become a fact of life. Joint development efforts, such as the French, Spanish, and Italian Helios collaboration or the Chinese and Brazilian remote sensing satellite venture are illustrative examples. Efforts such as these have prompted Rear Admiral Thomas A. Brooks, former Director of Naval Intelligence, to state, "the increased commercial availability of space-based remote sensing technology will allow any country that desires to have a space-based reconnaissance program to acquire one in the next decade."[4] With the serious economic problems it is currently experiencing, the former Soviet Union is also a potential source of advanced technology for anyone willing to pay for it. Unemployed space scientists and engineers may be more than willing to work for other nations on their space programs. Russia itself may even be willing to sell satellites to obtain hard currency.

Such examples highlight the possibility that satellites with greater military utility will evolve in the future.

## Greater Availability

In addition to satellites with improved military utility becoming available, more countries may be able to afford them. One way to reduce the cost of satellite acquisition is to share costs with other nations. Many countries have done this in the past. For example, the European Space Agency, formed in 1973, consists of 15 countries dedicated to the exploration and exploitation of space. In addition to a variety of scientific ventures, this consortium has launched numerous weather and communications satellites, as well as the previously cited ERS-1.[5] Similarly, 22 Middle Eastern countries pooled their resources to form the Arab Satellite Communications Organization in 1976 and now have their own Arabsat communications satellite system.[6] Five South American countries also pooled their resources to form the Andean Satellite Telecommunications Organization and hope to have their own operational communications satellite system next year.[7] Fifty African countries are studying a similar approach to satisfy their own aspirations.[8] Individual countries may also choose to pursue smaller joint ventures, as France, Italy, and Spain have done.

As technology matures, the cost of satellites may also decrease--just as the cost of electronic calculators has. In 1973, I paid $42 for one that was capable of nothing more than addition, subtraction, multiplication, and division. At the time it was a bargain. Today I can buy an equivalent one for less than a dollar.

When it comes to satellite technology, Michael I. Yarymovych, vice president of Rockwell International's strategic defense center predicts, "within three years, reconnaissance satellites with 3- to 5-meter resolution could be built or purchased for about $60 million, and that includes launch and ground support."[9] If satellites become more sophisticated and more countries are able to acquire them, space-based systems for other countries could pose a very serious threat to US military forces in the next century.

# CHAPTER VI

## CONCLUSION

Lt Gen Moorman characterized Desert Storm as a "watershed event in military space applications because, for the first time, space systems were an integral part of terrestrial conflict and were crucial to its outcome."[1] US forces effectively used a vast array of satellites available to them to enhance their ability to conduct combat operations. Communications satellites facilitated effective command and control by providing US forces with a great majority of their intratheater circuit requirements, as well as all of their intertheater circuit needs. GPS satellites enabled ground troops to navigate through the featureless desert, aircrews to precisely locate and attack ground targets, and smart weapons to hit their targets with pinpoint accuracy. Meteorological satellites provided users with current weather information about the theater every four hours, enabling US forces to optimize tactical plans, target selection, and weapons loads. Civil remote sensing satellites provided multispectral imagery used to update and provide more detailed maps for ground forces and air mission planners.

As a consequence of the advantages satellites provided US forces in the coalition's decisive victory, other nations may desire to provide their military forces with similar capabilities.

Some nations have already hinted as much. Many nations already have satellites that could be used by their own military forces and more are developing them. The former Soviet Union had a robust satellite program that provides them with virtually every capability US forces had except a fully operational GPS, which they are in the process of deploying. Numerous countries already have communications satellites--some even dedicated for military use. Many countries also have weather satellites. In addition a growing number of countries have remote sensing imagery satellites or are acquiring them.

While the former Soviet Union and China may be the only countries with dedicated reconnaissance satellites, more countries will be able to obtain them in the future. As technology matures and proliferates, some current generation satellites may acquire greater military utility. Similarly, countries who could not previously afford satellites may be able to obtain them in the future. As a result, the Twenty-First Century will probably see an greater number of forces with access to space-based capabilities comparable to those available to US forces in the Gulf War.

Given the numerous potential sources of instability in the world, the US will probably become involved in future military conflicts. We are likely, in the next century, to be opposed by military forces with access to force enhancement satellites. If we hope to overcome those forces as quickly as possible and minimize our own casualties, US forces must be able to deny an adversary's use of those satellites. Therefore the US must develop an ASAT capability which will enable our forces to do just that.

# NOTES

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## GLOSSARY

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|---|---|
| ASAT | Antisatellite |
| CENTCOM | Central Command |
| DMSP | Defense Meteorological Support Program |
| DSCS | Defense Satellite Communications System |
| DSP | Defense Support Program |
| EHF | Extremely High Frequency |
| ELINT | Electronic Intelligence |
| EORSAT | Electronic Ocean Reconnaissance Satellite |
| ERS | European Remote Sensing |
| GLONASS | Global Navigation System |
| GPS | Global Positioning System |
| MACSAT | Multiple Access Communications Satellite |
| MSI | Multispectral Imagery |
| NATO | North Atlantic Treaty Organization |
| NOAA | National Oceanic and Atmospheric Administration |
| RORSAT | Radar Ocean Reconnaissance Satellite |
| SHF | Super High Frequency |
| SLAM | Stand-off Land Attack Missile |
| UHF | Ultra High Frequency |